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Experiences and future prospects for tree seed supply in agricultural development support – based on lessons learnt in Danida supported programmes 1965-2005

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Introduction

The objective of this Danida Working Paper is to present lessons learnt in tree seed supply, and to provide operational guidelines for the integration and promotion of good practice in this field, as part of relevant development assistance to sector programmes in line with overall Danida policies.

The paper is targeted at professionals working with formulation, implementation and monitoring of sector programme support.

Support for improved tree seed supply systems has been a priority in Danish development assistance to forestry and agroforestry since the mid-1960s. Approximately DKK 500 million has been spent on this purpose in more than 20 countries over a period of 40-50 years. Other donors have also invested in this area (among others Canada, France, UK, the Netherlands, Belgium, USA, and Norway), while some 50 national tree seed centres have been established throughout the tropics from 1960-2005. In addition, several international organisations, such as FAO, IUFRO, ICRAF and IPGRI, have provided worldwide support.

The approach has varied from one region and country to another, as well as over time. Focus has generally been on production, supply, physical infrastructure and capacity building. National tree seed centres and programmes comprising seed procurement, tree breeding and conservation of genetic resources have been established. Priority has typically been given to productive aspects of tree seed supply directed by public institutions, but in some cases also to the normative functions of providing standards, guidance and mechanisms to influence and monitor the use of seed. The duration of donor support for such programmes has varied from 5 to 20 years. Some programmes continue to exist after donor withdrawal, whereas others have almost disappeared.

Even in the presence of existing national programmes, the lack of tree seed, seedlings and other good-quality planting material is repeatedly identified as a major constraint on greater adoption of tree planting and, in particular, agroforestry innovations.

In addition to the challenge of projecting and meeting the quantitative demands of farmers and other tree planters, issues of seed quality and genetic diversity still need to be addressed when designing and implementing effective seed supply strategies and policies.

During the last decade, there has been a clear call for decentralisation of tree seed supply with greater involvement of individuals, communities and the private sector. These goals have also been pursued in Danida’s support.

Against this background, Danida decided to commission the study presented in this paper. It has been carried out in collaboration between Forest
& Landscape Denmark (now ‘chapeau’ of the former Danida Forest Seed Centre), and the World Agroforestry Centre (ICRAF) based on the large body of practical experience in the field of tree seed supply, in particular from past Danida support and a recent programme implemented in cooperation between ICRAF, Danida and FLD entitled Improved Seed Supply Systems for Agroforestry in African Countries (ISSAAC), 2000-2006.

The busy reader should concentrate on the summary overleaf as well as the conclusions at the end of the paper.

Women engaged in manual seed cleaning at Centre National de Semences Forestières (CNSF), Burkina Faso. CNSF deliberately avoids introducing mechanized seed cleaning in order to provide job opportunities, mainly for women. Phot. Søren Moestrup 1989.
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Acronyms and abbreviations

AECI Agencia Española de Cooperacion Internacional
CATIE Centro Agronomico Tropical de Investigacion y Ensenanza, Costa Rica
CBO Community based organization
CNSF Centre National de Semences Forestieres, Burkina Faso
Danida Danish International Development Assistance
DFSC Danida Forest Seed Centre
DKK Danish Crowns
FAO Food and Agriculture Organisation of the United Nations
FLD Forest & Landscape Denmark
ICRAF International Centre for Research in Agroforestry (now World Agroforestry Centre)
ICRISAT The International Crops Research Institute for the Semi-Arid Tropics
IFSP Indonesia Forst Seed Project
IPGRI International Plant Genetic Resources Institute (now Bioversity International)
ISSAAC Improved Seed Supply Systems for Agroforestry in African Countries
IUFRO International Union of Forest Research Organisations
KVL Royal Veterinary and Agricultural University (now Faculty of Life Sciences, Copenhagen University)
NARS National Agricultural Research Systems
NGO Non Governmental Organisation
NRM Natural Resources Management
NTSC National Tree Seed Centre
NTSP National Tree Seed Programme
PROSEFOR Proyecto de Semillas Forestales, CATIE
PSFV Production de semences et conservation des ressources forestieres dans les terroirs villageois, CNSF
QDS Quality declared seed
TIC Teak Improvement Centre, Thailand
TIL Truth in labelling
TIP/TISC Tree Improvement Programme/Tree improvement and Silviculture Programme, Nepal
TSSDP Tree Seed Source Development Project, Indonesia
Summary

Investment in agricultural productivity is necessary to bring about structural transformation and economic growth in developing countries. Crop and tree seeds are essential inputs to the agricultural sector. Good seed may increase production manifold, and is thus important to the livelihoods of smallholder families. As many species grown by farmers in developing countries are perennials, agroforestry practices and tree breeding should often contain a mix of approaches and techniques from agriculture, horticulture and forestry. Emerging evidence confirms that trees on farms have promising future prospects.

Analyses of the trends in tree planting and in tree and crop seed supply systems over the last forty to fifty years show that:

1) Trees on farms are part of agriculture. Tree planting by smallholders occurs as a mix of forestry, agriculture and horticulture, i.e. as part of agroforestry in its broad sense.

2) Efficient seed and seedling supply is only likely to be achieved if considered as part of a commercial commodity chain in a market that encourages the operation of small, competitive seed and seedling retailers.

3) Severe market distortions caused by free seed and seedlings of inferior quality needs to be removed.

4) Seed markets need to be further developed at the local level by issuing ‘good norms’ and by promoting regional markets. Such development requires impartial public norms.

5) Publicly supported breeding and conservation programmes should provide input to private seed retailers.

The biological and technological aspects of providing good seed have been brought to light in the public domain and are, in principle, well known. Public institutions (which were endowed with the knowledge and carried responsibility for production in the early years) often had high transaction costs, which frequently led governments and donors to privatise or abandon public production of tree seed. The basic assumption behind this was that the technology was simple, and that good practice in seed supply to small farmers could be undertaken by communities and NGOs. However, this assumption has proved to be false, and the resulting widespread distribution of free but inferior seed has been detrimental to the adoption of good practice. The delicate interaction between technology and organisation requires a helping hand to make input supply systems efficient and market-driven.

Subsector analysis is a useful tool to identify constraints on and opportunities for development of an efficient tree seed system, as well as to identify the current and potential actors and their roles.

There has to be a division of labour between public and private actors, including NGOs, whose activities frequently substitute for government serv-
ices, thus being public as well as private in nature.

In the case of input supply chains, as a general principle of good practise, this paper suggests that government services develop regulatory frameworks, guidelines and training programmes (with support from NGOs), including marketing and promotion of existing and new species. NGOs should conduct training programmes for small-scale entrepreneurs, supporting collective action by these private sector actors. Small-scale entrepreneurs should have a major role in production, procurement and distribution of reproductive material. Establishment of sources is the backbone of the whole system, and ensuring their quality as well as commercial value is one of the most important functions of the support for the input supply chain.

1.1 Tree planting in developing countries

Trees are planted for a variety of purposes. It is common to differentiate between ‘industrial plantations’, established to produce wood for industry, mainly saw logs, veneer logs, pulpwood and mining timbers; and ‘non-industrial plantations’ established for fuel wood, wood for charcoal, wood for domestic consumption, non-wood products, and soil protection.

In recent years, attempts have been made to accelerate the recovery of degraded natural forests and deforested lands in order to restore productivity, biodiversity, and other values, e.g. mitigating global warming. Trees are also planted in agroforestry systems by smallholders for livelihood improvement and cash income.

Trees planted in plantations and for recovery of degraded and deforested lands are included in national and international forest statistics. For example, the area of forest plantations in the tropics increased more than thirteen-fold between 1965 and 2000, and continues to expand at an even faster growth rate. Most of this activity to establish industrial plantations and protect the soil, however, is concentrated in a few countries, e.g. China and Brazil, and is of limited importance to smallholders.

Trees planted outside regular forest areas are not included in the traditional definitions of plantations and forests. Nevertheless, these ‘trees outside forests’ make a significant contribution to the environment, and provide substantial social and economic benefits, in particular to smallholders in developing countries. Where forest resources are scarce, especially in densely populated areas, trees outside forests are a major source of food, fodder, fuel wood, and cash income. For example, in Kenya, trees on farms produced almost 10 million m³ of wood in 2000, and in some densely populated areas contributed 18-51% of total household income.

Although reliable statistics on the extent of trees outside forests are hard to collect, the emerging evidence confirms that most trees are now planted outside forests, and that trees on farms have promising future prospects.

Compared to traditional tree plantation establishment, this development poses at least three major challenges for the supply of planting material (input supply):

(i) There is interest in a much wider array of species and crops, including fruit trees (like mango, avocado and apples), major tropical and subtropical perennial crops (like coffee, cacao, and rubber), as well as a vast
number of indigenous species (for which scientific and local knowledge indicates economic potential) and exotic agroforestry species (such as fodder shrubs and timber trees).

(ii) Delivery of planting material to large numbers of smallholders requires logistics different from what is needed for plantation forestry. For smallholder agroforestry, sources of reproductive material as well as delivery networks need to be decentralised in order to reach the smallholders interested in planting.

(iii) Demand from smallholders for planting material is linked to demand from customers for agroforestry products. Efficient value chains for agroforestry products have to encompass efficient input supply chains. The sources define the quality of products, while the efficiency of input supply networks defines the number of smallholders growing the products. Smallholders will have greater demand for planting material of species that they believe can improve their livelihoods and cash incomes.

Figure 1. The importance of seed quality and possible gain from domestication for and by smallholders. The figure illustrates the relation between intensity of domestication and economic gain from improved volume production. The level of seed quality increases from left to right. Underperforming seed quality places many tree plantings in the ‘red area’, instead of the ‘green area’, where they ought to be. Domestication intensity is a choice based on the importance of the species under domestication. The number of planters who benefit from domestication depends on the efficiency of input supply systems.
1.2 The role of good seed and good practise in tree seed supply for smallholders’

Trees and shrubs grow from seed, cuttings or grafts, all referred to as reproductive material, planting material, ‘germplasm’ or for simplicity often just ‘seed’. Good ‘seed’ means that the plants that grow from such reproductive material are healthy, grow vigorously and deliver products of high quality (see further in box 1).

The importance of good seed is illustrated in figure 1, which shows that there is a range of possible seed qualities – from highly improved seed (made through intensive breeding) to highly degraded seed (from inbred material or material that has lost the good genes). In real life, highly improved seed is rarely available to smallholders, whose only immediate option is often degraded seed.

Common sense should, in principle, be sufficient to keep out of the red area in the graph above. Good practise is first and foremost a question of choosing and using appropriate seed sources (see box 1). It does, however, require that appropriate sources exist, that distribution networks make good seed available to smallholders, and that knowledge is available about the benefits of growing particular species. Good practise thus requires a number of conditions to be simultaneously fulfilled. One way of evaluating good practise in tree seed supply is to look at the efficiency of input supply chains, which determines both the number of smallholders who get access to grow particular crops and the quality of these crops. The demand for input is driven by the demand for agroforestry products and the extent to which demand for these products can be created and satisfied. Figure 2 illustrates these relationships.
**Box 1. What does good practice mean?**

**Improved input supply to smallholders**

The result of ‘good practice’ should be that seed and seedlings of good quality of wanted species reach the tree planters in a timely and sustainable manner at affordable prices. Good practice can be evaluated through understanding and analysing the sub-sector (sub-sector review).

Good practice involves (i) the provision and promotion of suitable seeds and seedlings in input supply markets (‘good governance’) and (ii) technical solutions that are sustainable (‘sustainable technology’). These two points are so-called ‘areas of leverage’.

**Good governance**

Provision and promotion of suitable seed in a sustainable manner encompasses at least three important aspects. First, that provision and promotion are at a level and involves a technology that can be continued and developed by the seed procurement agents in liaison with the seed users. Second, that the seed procurement agents will be capable of generating revenue that can partly or fully sustain their seed procurement operations. And third, that the government is prepared to support in particular the promotion of good practice in seed procurement among seed suppliers and seed users to achieve not only financial sustainability, but also economic and environmental sustainability. It is important to note, that demand should not be met by one single seed procurement institution but rather by several different actors or stakeholders.

**Appropriate technology**

Sustainable technical solutions refer to the choice of species and to the genetic composition and the physiological constitution of the plant material supplied. Species in demand, satisfying end-use needs and matching planting site, should be available to the tree planters. Genetic suitability refers to maintaining and improving genetic quality through the use and maintenance of proper seed sources, through tree improvement activities, and through conservation of the genetic resources for future use. In particular, conservation of genetic resources is a long-term investment, and will therefore in general require public support. Appropriate physiological condition implies that seed handling methods should sustain germination capacity and vigour.

Thus, the result of ‘good practice’ depends on a long chain of good practices involving many different actors.

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*Countries and institutions with programmes on management of genetic resources of trees supported by Danida 1965-2005. The period and type of support have varied from country to country.*
2. Past experience of tree seed production, procurement, and distribution, as well as recommendations for the future

The understanding of good practise in tree seed supply has evolved over time. The development of ideas and practises for tree and crop seed systems has undergone changes over the past five decades, fairly consistent with mainstream trends in rural development. By and large, the changes in approach to crop seed systems precede the changes in thinking on tree seed/seedling systems by a decade or more.

Table 1 provides a timeline of major development ideas and practises for tree seed production and distribution. Roughly, the experience so far can be summarised under four headings: 1. national tree seed centres, 2. NGO and community seed production, 3. taking in lessons from crop seed systems, and 4. overcoming constraints.

2.1 Lessons learnt from national tree seed centres

A global programme

FAO initiated a Global Programme for Conservation and Management of Forest Genetic Resources in the early 1960s, which became a formal as well as informal framework for the operations of numerous governments and donors. In the 1960s and 70s, support was provided for breeding programmes of industrial tree species, such as teak, tropical pines and eucalyptus. Subsequently, a number of international and national government-run tree seed centres were established to propagate and distribute the improved material to plantation programmes.

With a focus on industrial tree species, these tree seed centres could obviously not meet the demands of the new planting programmes that emerged with the change in development programmes from industrial plantations to rural development tree planting activities. A new wave of national tree seed centres therefore came ashore in the 1980s and 1990s, very often seen and planned within the context of National Forestry Action Plans. Very much in accordance with the global programme, national tree seed centres have been established in some 50 tropical countries over the last 40 years with international development assistance from Canada, Denmark, the Netherlands, United Kingdom, France, Belgium, Germany, Norway and United States.

In response to the needs of rural tree planting programmes, most of these centres worked in the 80s and 90s with a fairly large number of multipurpose species. In general, the centres had productive as well as normative functions.
<table>
<thead>
<tr>
<th>Period</th>
<th>Development idea</th>
<th>Objective</th>
<th>Identified limitations</th>
<th>Danida projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960s and</td>
<td>Breeding, gene conservation, seed production and distribution of industrial tree</td>
<td>Improved reproductive material to plantation programmes to supply raw material for industry</td>
<td>Some programmes failed due to lack of market. Smallholders not conceived as part of the development process.</td>
<td>• Teak Improvement Centre, Thailand (TIC) 1965-1975</td>
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<td>1970s</td>
<td>species by Public Agencies. Technical training</td>
<td></td>
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<td>• Pine Improvement Centre (PIC) 1975-1985</td>
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<td>• Indo-Danish Tree Seed Programme 1971-1979</td>
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<td>• Malawi Tree Breeding Programme, 1970’ies</td>
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<td>• Zambia Tree Breeding Programme, 1970’ies</td>
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<td>1980s and</td>
<td>Seed production and distribution of multipurpose tree species, breeding and gene</td>
<td>Improved reproductive material to rural plantation programmes in support of rural household needs and small-scale agriculture.</td>
<td>High transaction costs. Limited penetration of the informal sector.</td>
<td>• Nicaragua Tree Improvement and Seed Centre 1983-1997</td>
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<tr>
<td>1990s</td>
<td>conservation by Public Agencies. Training, extension, technical and regulatory</td>
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<td></td>
<td>• Tanzania National Tree Seed Programme 1989-2000</td>
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<td>guidelines by the same Public Agencies.</td>
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<td>• Nepal Tree Improvement Programme 1992-1997</td>
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<td>• National Tree Seed Centres established in Ethiopia, Sudan, Uganda, Eritrea and Laos.</td>
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<td>• Indonesia Tree Seed Source Development Programme TSIDP 1993-1997</td>
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<td>1980s and</td>
<td>NGO production. Shift of support from centralised to decentralised nurseries.</td>
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<td>Market distortion: distribution of free but inferior seed and planting material. Seed production by local</td>
<td>• Nepal Tree Improvement and Silviculture Component 1998-2002</td>
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<td>1990s</td>
<td></td>
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<td>growers as a business discriminated against.</td>
<td>• Production de semences et conservation des ressources forestières dans les terroirs villageois</td>
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<td>(PSFV) 1998-2001</td>
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<td>• IFSP/ICRAF Indonesia</td>
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<td>2000s</td>
<td></td>
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<td>Investments in breeding and gene conservation lose importance.</td>
<td>• Indonesia Forest Seed Project (IFSP) 1998-2002</td>
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<td>• Vietnam Tree Seed Project (VTSP) 1998-2005</td>
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<td>• Gene conservation programme, Thailand 1990-1993</td>
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<td>• Forest Genetic Resources Conservation and Management Programme FORGENMAP, Thailand 1997-2002</td>
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<td>• Cambodia Tree Seed Project 1999-2006</td>
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<td>2000s</td>
<td>Community-level seed enterprises (helped by NGOs)</td>
<td>Improve reach to smallholders</td>
<td>Insufficient demand at the individual village level to maintain a commercial seed enterprise. Retail</td>
<td>Continuation of the NGO Production in the 1980s and 1990s</td>
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<td>trading networks not developed.</td>
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<td>2000s</td>
<td>Increasing smallholders’ access to appropriate sources of tree seed through</td>
<td>Broader access of source seed. Support small scale commercial seed sector by reducing transaction costs in wholesale and retail seed</td>
<td>Requires public commitment and implementation on a relatively large scale.</td>
<td>• ISSAAC Improved Seed Supply Systems for Agroforestry in African Countries 2000-2006</td>
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<td></td>
<td>supporting development of a small scale commercial seed sector</td>
<td>markets; and by removing market distortions. Revitalise international collaboration to promote regional breeding and conservation programmes</td>
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<td></td>
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<tr>
<td>2000s</td>
<td>Millenium Villages Project</td>
<td>Improved reproductive material to villages in support of rural household needs and small-scale agriculture.</td>
<td>High transaction costs. Limited penetration of the informal sector.</td>
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Lessons learnt from Danish support for national tree seed centres

Denmark has a long-standing record of contributing to the tree seed sector. The Danida support has formed part of a wider international effort. FAO took the lead in the early 60s and was instrumental in the establishment of both the Australian Tree Seed Centre (1965) and the Danish/FAO Tree seed Centre (1969), which both became important vehicles for technology development and transfer in the following approximately 40 years. With the FAO Panel of Experts on Forest Gene Resources, FAO formulated a global programme that encompassed the work with forest genetic resources of several expert institutions.

In the period 1965-2005, Danida was one of the major and most influential donors providing support for tree seed or tree seed related projects in more than 20 developing countries. Accordingly, the history and the lessons learnt in the course of Danish assistance provide a general picture of the various approaches applied.

One striking feature of Danish and international support for the tree seed sector has been a fairly constant development objective, the aim being to provide reproductive material to improve tree plantings. Another major characteristic has been the generally long-term nature of the support.

Lessons learnt. International support has enabled the establishment of a global network of tree seed programmes as an essential (implementing) part of forest genetic resources work. Diminishing technical and policy level support is currently weakening this network, even though seed programmes are still essential. There is a need to rethink the relation between objectives and operational means by which the target groups are reached in order to make the network relevant to present-day challenges.

Industrial plantations

In the early years, the focus was on forest tree species for industrial purposes (teak in Thailand 1965-1970, tropical pines in Thailand 1975-1980, conifers and selected broadleaved species in India 1976-1980 and in Nicaragua 1983-1990, tree breeding programmes in Malawi and Zambia in the 1970s). Of these programmes, the Teak Centre in Thailand and the state-owned tree seed centres in India are still - several decades later – operating on a mix of public funding and income generation from sales of reproductive material. The pine breeding programme in Thailand and the tree breeding programmes in Malawi and Zambia did increase tree production, but the programmes ceased because they were meant to serve pulp and paper production plants that never materialised. Tree breeding and gene conservation of valuable tropical hardwoods, such as teak, were no doubt pioneering, provident and foresighted programmes. However, in some ways, they turned out to be ahead of their time. The continued availability of these species from natural forest limited the interest in investment. The last natural teak forests, however, have now almost disappeared, and the interest in plantation development is growing dramatically.
The lesson learnt is that investment in industrial tree species can be worthwhile, if the product is sufficiently valuable, and if there is a market for it. Public investment in programmes for gene conservation of valuable species is required, as long as it is more profitable to harvest the natural forest, whether legally or illegally.

Multipurpose species and seed supply


All centres were designed to meet what was considered to be large shares of national demand, varying from a few to several hundred tons of tree seed, and from a handful to hundreds of species. The market analyses preceding the establishment of the centres were largely built on national sector planning at the time (e.g. national forestry action plans), tending to ignore the emerging informal on-farm activities. The centres generally met their production targets, but probably never their market share targets. The latter point has, unfortunately, not been thoroughly investigated, but studies from Tanzania and Nepal show that as little as 10% of the potential market was supplied, and that the uncovered share was largely the informal market of tree planting farmers.

The lesson learnt seems to be that public, centrally located seed production centres serve primarily the formal plantation sector, and have been unable to reach poorer farmers and communities in rural areas using and planting trees for a multitude of purposes.

This weakness was in fact recognised in the early 1990s, when DFSC proposed to add small, decentralised extension focal points to the centres in Sudan and Tanzania in order to meet the demands of the informal sector. However, the proposal failed to gain widespread support, and was never implemented. Attempts to this effect were made in Nepal, where user surveys were drawn up, tree seed co-operatives established, and strategies developed for satisfying smallholders’ demand and creating a decentralised market for tree seed.

The lesson learnt is that, provided partial government support is sustained after the withdrawal of donor funding, it appears possible to establish viable tree seed centres in developing countries. However, as the attention shifts from industrial plantation establishment to support for smallholder plant-
ing, the impact of national tree seed centres still pursuing the original development objective appears to have waned due to the decentralised nature of demand.

Another lesson learnt is that the informal market is large, holding vast development potential, and that a different approach is needed to realise this potential.

Seed production and seed quality

In seed production, the early industrial programmes concentrated on relatively intensive breeding of a few priority species (e.g. Thailand TIC). The following more rural development oriented programmes focused on seed supply, mainly based on natural seed sources (e.g. Tanzania NTSP), which, however, often ran into problems regarding seed source management and conservation, as well as seed quality (e.g. Indonesia TSSDP and Uganda NTSP). Physical seed supply was the main aim of most of the programmes (with important exceptions, such as Indonesia IFSP, 1998-2002 and Central America PROSEFOR, 1991-1998), often supplemented with elements of tree improvement and/or gene conservation in so-called integrated national tree seed programmes.

While producing and distributing seed mainly to governments and donor-supported rural development programmes, the centres also had a normative role in the tree seed sector by preparing plans for tree improvement and gene conservation, establishing and certifying seed sources, providing training and extension services, and preparing guidelines for use and matching of seed sources to planting sites.

As donors withdrew and national tree seed centres needed to become more financially self-reliant, the protection and use of seed sources and gene conservation areas scattered over vast geographical areas became too burdensome for most programmes, while the costs of tree breeding and gene conservation, and the relatively long time horizon for economic returns generally resulted in exclusion or downsizing of these programme elements at the centres. Consequently, some programmes chose different strategies for breeding and establishment of seed orchards, using low-cost approaches and combining testing with breeding, seed production and conservation of genetic diversity in the same orchards (e.g. Nepal TIP/TISC).

A lesson learnt is that short-term income required to sustain commercial seed sale is difficult to combine with longer-term investment in breeding and conservation. This specific lesson relates to the general one formulated below, namely that commercial business and public sector services in the same institution is a problematic mix, since investment in breeding and conservation is considered to pertain to the public sector.

Another lesson learnt is that gene conservation and, to some extent, breeding as well, will rarely be implemented in practice unless physically integrated with seed production.
The functions of tree seed programmes

In terms of the functions of national tree seed programmes, a distinction can be made between productive and normative functions. The productive functions comprise short-term operations of seed supply and long term investments in tree breeding and gene conservation. The normative functions include policy measures, regulating mechanisms and dissemination of information to promote appropriate use.

The early-established centres focused almost exclusively on the productive functions. From the early 90’s the tendency was to try to cover both productive and normative functions. At the same time it became an expectation that the centres should become at least partly self-financing based on commercial seed sale. The centres should thus embrace a mixture of commercial business and public sector services.

The normative functions first became a strategic part of the second generation of tree seed programmes that focused on rural development (e.g. Nepal TIP/TISC, Burkina Faso CNSF/PSFV) and of the normative functions, training and dissemination of information was very dominant (e.g. Tanzania NTSP), in some programmes even exclusive (e.g. Central America PROSEFOR 1991-1998, Indonesia IFSP 1998-2002).

The rationale of priority to training and information was that an attempt to provide legislation and regulation would be counterproductive before the market was aware of appropriate standards and before such standards could be made available. There is obviously a potential conflict between the normative and the productive functions. Vesting regulating (normative) functions and operational (commercial) seed supply activities with the same authority could violate the overall ideal objectives and suppress possible private competition, which otherwise could serve further dissemination. Ideally, the role of most of the tree seed centres was to ensure the integration of and an appropriate balance among the different functions and the different possible performers of the functions. In practise, this has not proven to be possible following donor withdrawal. The demand to become a financially self reliant seed enterprise will inevitably create an institution that will compete with other seed enterprises. Such an institution should obviously not be leading in providing norms for its competitors. Although most of the centres that were established with donor support continues to operate (cf. above), it is apparent that the demand to be partly financial self-reliant has had the effect that in most cases focus is primarily on the commercial business as a tree seed enterprise and that this has been at the expense of the normative functions and at further investments in tree improvement and gene conservation. Following donor withdrawal of Nepal TIP/TISC and Indonesia TSSDP, focus changed from operational tree seed supply to normative functions. In Indonesia it happened via a new donor supported project Indonesia IFSP. In Indonesia it is interesting to note that national public funding to the normative functions have increased considerably during and after the purely normative IFSP.
A lesson learnt is that the mixture of commercial business and public sector services in the same institution apparently usually fails to function. A commercial seed enterprise should be separate from the normative functions of providing policies, legislation, and regulation of the market and of providing independent advice and guidance to users.

Institutional capacity in the tree seed sector

Different strategies have been applied to build, mobilise and develop the institutional capacity of the tree seed programmes:

2. Capital investments (facilities, seed sources, new knowledge on socio-economic aspects, new methods and technologies).
3. Economising resources: efficient use of existing resources (planning, less administration, delegation of responsibilities, sharing skills and experience).
4. Sustain existing economic forces (marketing, information, influencing financial mechanisms, extension).

In the early years, the main emphasis was on training (e.g. international and regional technical training courses in Denmark 1966, Thailand 1973, Kenya 1975 and Central America 1980). Later, this was coupled with more intensive capital investment (most of the national tree seed centres were inaugurated in the period 1989-1992), while more recently, resource economising and stimulation of existing economic forces have been added.

Capacity development strategies have grown in complexity from consisting basically of education and capital investment to include the development of private sector interests (e.g. Nepal TISC seed co-operatives, Burkina Faso PSFV ‘village seed’, Indonesia IFSP/ICRAF) and building upon local social and cultural patterns and traditions (e.g. Burkina Faso PSFV).

The Danish assistance to the establishment of national tree seed centres in the tropics has thus evolved in response to the general development of the forestry and agricultural sectors, and the roles assigned to the centres has also changed over time. The Danish experience in the tree seed sector is highly valuable in efforts to improve smallholders’ access to quality material – as will be described in the following.

2.2 NGOs, nurseries and community seed production and distribution

In many countries, NGOs have taken over much of the role in tree seed supply originally assigned to the national tree seed centres. NGOs are now major suppliers of tree seed and seedlings to farmers. The increasing importance of NGOs in this field follows a rising trend towards donor support for NGOs involved in agricultural development. The NGOs are seen as more efficient and cost effective, which appears to be a major justification for NGOs taking over many functions in agriculture that used to be performed by the state.
Recent surveys show, however, that a frequent problem with NGO supply is the lack of concern or control regarding the genetic quality of the reproductive material, and that the limited time horizons of NGO projects often fail to address the long-term maintenance and protection of seed sources. This is probably due to lack of awareness on the supply as well as on the demand side. Furthermore, seed and seedlings from the NGOs are generally supplied on a relief basis, i.e. free of charge, which impinges severely on the profitability of market-based commercial seed dealers and private nurseries. The small private entrepreneurs (nurseries and seed vendors) that have appeared in some areas are generally not included in the NGO networks. Instead, the NGOs usually choose to set up their own project-based networks of group nurseries.

The NGO approaches to the production of tree seed have been very similar to those applied to crop seed, and the lessons learnt from crop seed systems, as described below, are equally relevant to tree seed systems.

2.3 Lessons from crop seed systems

Tree seed/seedling systems can generally be described as dysfunctional with respect to their ability to reach smallholders, despite considerable publicly funded support from national tree seed centres and NGOs. This may give the impression that good reproductive material cannot be placed in the hands of smallholders. However, it may be useful to look at the history of crop seed systems to search for alternative solutions. The development of crop seed systems has been very similar to that of tree seed/seedling systems, except that change has tended to occur earlier in the case of crop seed systems. Nonetheless, there has been limited diffusion of lessons learned from crops seed to tree seed/seedling systems.

As in the case of tree seed/seedling systems, support for crop seed systems was initiated in the 1950s and 1960s through establishment of parastatal organisations for production, distribution and certification of seed. These organisations were found to be inefficient in reaching smallholders. Subsequently, they were privatised. Privatisation of the parastatals, however, did not improve smallholders’ access to the majority of crops (except, to some degree, for hybrid maize and sorghum). Some ten-to-twenty years after the privatisation of crop seed parastatals, national tree seed centres began to be privatised.

During the 80s, an increasing number of NGOs became involved in seed production and distribution of the many crop species and varieties in which the commercial sector is reluctant to engage. In a study of 19 NGO projects in nine low-income countries in Africa, South Asia and Latin America, only a few were promoting local seed production as a business. Almost all the projects depended on relatively intensive and costly inputs from the NGOs. Wiggins and Cromwell (1995) point out that the majority of these NGO programmes have been small-scale, and that up-scaling would require an enormous increase in NGO funds devoted to seed activi-
ties. Some ten years later, NGOs began to engage heavily in tree seed and seedling distribution.

During the 90s, a large number of projects in Africa, Asia and Latin America pursued community-level seed enterprises as an alternative source of seed of non-hybrid varieties. Tripp and Rorbach (2001) point out that, typically for the projects (at least) in Africa, farmers were organised and trained in seed multiplication techniques, and were then expected to use part of the seed on their farms, and to sell the rest to neighbouring farmers. The theory was that this activity would evolve into a financially viable village-level enterprise. Tripp and Rorbach (pages 157-158, 2001) conclude: “We know of no case where a sustainable small-scale seed enterprise has emerged from this type of activity. The reasons are fairly obvious. In the first place there is simply not sufficient demand at the individual village level to maintain a commercial seed enterprise, and farmer seed producers usually have few contacts outside their villages. … If the full costs of source seed, seed inspections and advisory services are included, the probability of maintaining a financially viable enterprise after the termination of project support is very low.” Variants of this model are now the dominant and most popular one for tree seed/seedlings, in particular in Africa.

The free distribution of seed in emergencies has become a major constraint on the development of commercial enterprise supplying seed of a wide range of crops. Tree seeds/seedlings are distributed freely as a matter of routine.

For crop seed systems, the latest school of thought is that market failures for commercial production and distribution should be overcome through active engagement in crop seed markets. In particular by: (i) increasing effective demand for improved varieties among smallholders; (ii) decreasing the cost of seed production and distribution; (iii) improving infrastructure, rules and regulations. In combination, these considerations give rise to calls for better co-ordination of public and private sector investment in the development and dissemination of new varieties. A similar approach was proposed by Danida Forest Seed Centre (DFSC) fairly early in relation to the national tree seed centres (but never gained widespread support). For tree seed/seedlings, this idea has only been applied in a few cases of development practise (e.g. two ICRAF projects in South East Asia: a tree seed project in the Philippines, funded by Spain, and a tree seed project in Indonesia, funded by Denmark).

Thus, the alternative suggested for crop seed systems is that the public sector should support the development of a private sector for distribution of tree seed, and subsidise breeding and production of crops that are suitable for smallholders1. A private sector is found in an incipient stage in tree seed/seedling systems in many African countries where private nursery enterprises and seed vendors carry out their business, but these enterprises are

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1 Gates foundation and Rockefeller foundation has started supporting this new development on a relatively large scale in Africa (http://www.gatesfoundation.org/GlobalDevelopment/Agriculture/default.htm).
rarely if ever supported by the public sector and NGOs. There is however, sufficient experience available to provide practical guidelines for improving the efficiency and reach of private enterprise in tree seed/seedling supply.

2.4 Overcoming constraints to development of a private sector for seed and seedlings

Tree seed/seedling supply does, however, differ from crop seed supply with respect to seed production. Trees and bushes are perennials, and it takes longer before a source can produce seed (annuals can produce seed the same season that they are planted). Therefore, tree seed sources must be maintained and protected for a longer period before they become productive and generate income for the owner. Furthermore, most trees do not tolerate inbreeding, and special care must be taken both when collecting seed for source establishment and when species are introduced into agricultural landscapes (many crops are self-fertilising and do tolerate inbreeding). A third aspect is that tree seed sources can produce large amounts of seeds, and the required density of seeds/seedlings by planting area is relatively low (as compared to crop seed). Consequently, markets for tree seed should be targeted on larger scales than for crop seed.

Despite these differences, general constraints on seed supply can be grouped into four major categories, which are common for both crop seed and tree seed/seedling supply systems. The section below sets out how to overcome these (based on personal communication with Richard Jones, ICRISAT).

(i) The cost of seed distribution

Discussion of constraints: High transaction costs raise the price of seed to unacceptable levels in rural markets, and leads national tree seed centres to limit their distribution to areas close to their centres and sub-centres, and NGOs to concentrate on procuring seed from farmland trees through collection of species that are locally available to NGO-supported nurseries. The high transaction costs are aggravated by the high overheads of NTSCs and NGOs. In contrast, smaller seed traders and private nurseries, without large overheads (including source protection and maintenance overheads of NTSCs), may be capable of supplying seed of many species at attractive prices.

While there is evidence that private nurseries and private seed traders are interested in expanding their capacity, the major constraint that they are facing is the public sector’s lack of recognition of their potential for participation in agroforestry input markets. An industry of small private seed entrepreneurs needs access to good germplasm, business networks, and marketing (extension) capacity. Therefore, the entrepreneurs’ role as important players in wholesale and retail trade systems is currently limited.

Recommendation: Smaller seed enterprises, without long-term and normative investment overheads, may be capable of supplying seed at competitive prices and of investing in building retail trade systems. Such commercial development should be supported.
(ii) The distribution of free seed  
**Discussion of constraints:** Markets are distorted by the distribution of free seed of inferior quality from NGOs and donors through development projects. If farmers are able to obtain free seedlings through development projects, they will not seek these through the retail market. The current distribution of seed and seedlings by non-specialised NGOs pays little heed to optimizing species choice and genetic quality, thereby undermining the potential of current farmland planting. There is, however, evidence that farmers maintain a large number of species on their fields, indicating an interest in a diversity of choice. In addition, it is often assumed that demand from farmers is quickly saturated making it difficult to base a business on seed and seedling sale. However, despite the competition from free handouts, seed/seedling entrepreneurs are still surviving.  

**Recommendation:** The distribution of free seed and seedlings should be replaced by more efficient retail markets and facilitation of production of a wider range of suitable species of high genetic quality.

(iii) Markets for commercial seed  
**Discussion of constraints:** National seed markets are too small to support significant commercial investment in breeding seed orchards (BSOs) and other types of sources. This can be overcome by establishing recommendation domains (planting zones) for species in demand; harmonising seed laws and regulations, creating a regional market large enough to spread marketing risks and promote economies of scale. Little progress has been made in the identification of harmonised standards for tree seed quality, trade regulation and recommendation domains for tree provenances, but there is already knowledge available of how to lay down standards and incorporate these into each country’s tree seed policies.  

**Recommendation:** International institutions and national tree seed centres may promote regional programmes and marketing strategies for entrepreneurs in order to spread marketing risks and promote economies of scale.

(iv) Seed sources and breeding  
**Discussion of constraints:** Finally, the issue of economies of scale determines returns on investment in the establishment of seed sources and in tree breeding. Public and private investment in low-input breeding remains severely limited – and is almost absent for high-value trees, except for the selection of clones of superior fruit varieties. Public investments in seed source development, identification of adapted provenances for a wider range of tree species, appear inconsistent and inefficient. In this context, international institutions (e.g. the World Agroforestry Centre) and national tree seed centres could help increase returns on investment in breeding and conservation by helping to source foundation seed for the private sector of key species and provenances, and by advising in source establishment and marketing (see also box 2).
**Recommendation:** International institutions and national tree seed centres could help increase returns on investment in breeding and source establishment by producing foundation seed for the private sector. Public funding is required, and investments in seed sources must be made profitable by linking up with a sufficiently large customer base.

Accordingly, a central issue is the choice to be made by the national and international research organisations, national tree seed centres, and NGOs between their own direct seed distribution and their support for development of best practises in the private sector in the production and distribution of seed and seedlings (see also table 4).

The next chapter describes the agroforestry input supply chains, suggesting how to identify leverage points to make chains more efficient and quality conscious. The purpose is to show how appropriate action (‘good practise’) can be identified in relation to specific national sector development programmes, which is a primary objective of this paper.

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**Box 2. The cost of tree seed and adoption of improved varieties**

It is not likely that the cost of seed is a major deterrent for adoption of agroforestry species by farmers. The cost of seed is a very small part of farmers’ overall investment in planting and maintaining shrubs or trees on their land:

The cost of (high quality) seed in plantation establishment in forestry is generally from 2 to 4% of total plantation establishment costs.

Compared to annual crop seed, the multiplication ratio (amount of seed that may be produced from one seed) for tree seed is very low (it is higher for vegetatively produced seedlings). For example for peanuts one seed will produce 10-20 additional seed and for pearl millet one seed will produce 160-240 seed (Tripp, 2001). For trees one seed may produce from thousands to millions of seed on an annual basis, but it will take longer to establish seed production from scratch.

The extra cost of producing quality seed - for example from farmland seed sources from a large minimum number of trees (e.g. 40 mother trees) as compared to random collection from a few trees – is for most species less than 5% per unit of seed collected.

The net present value of establishing seed sources of fodder shrubs with early fruiting (the benefits going to fodder tree planting farmers) is so high that it can be justified to establish 20 one hectare seed sources even if only one of these seed sources would eventually be utilised.

Studies of nurseries in Malawi, CBOs in Uganda and nurseries and seed dealers in Kenya indicate that private entrepreneurship in seed and seedling systems spontaneously appear, even in a hostile environment of distribution of free seed and seedlings (provision of free seed and seedlings is costly to arrange and organise and does not create long term capacity for continued availability of species).

It is more likely that farmers’ demand for species is shaped by the knowledge of potential benefits that can be derived from the species (as well as the availability of the species). This may be a major reason, why NGOs in southwest Uganda can charge farmers for well known varieties of fruit tree seedlings and a major reason for emergence of seed dealers for Calliandra fodder seed in the highlands of Kenya, where ICRISAT has been promoting fodder technologies for several years.
3. Tree seed subsector – assessing the production-procurement-distribution chains for tree seed

Seed and seedlings are produced and distributed by people in many different ways. Accordingly, there are numerous actual and potential actors, playing a variety of roles. A well-functioning seed system depends on good collaboration between the various actors. Seed production and distribution may become more successful by preparing an investment strategy that takes into account the constraints and opportunities of all the actors and their roles.

Investments should thus be based on an overall analysis of the tree seed/seedling sector (sub-sector assessment) in a particular country or part of a country, and the relevant government, donors and NGOs should evaluate where to invest most effectively, taking account of public and private collaboration.

3.1 Sub-sector analysis

The objective of a sub-sector assessment is to analyse all of the participants, their linkages, and influential factors in the agribusiness system in order to identify constraints and opportunities for growth. Such a sub-sector analysis of the tree seed and seedling sector does not differ from any other agribusiness sub-sector analysis.
The framework of a generalised sub-sector assessment for tree seed is shown in figure 3 above. The example, which should be close to reality in many countries in Eastern and Southern Africa (but not in all South East Asian countries), is based on cases from Kenya, Uganda, Burkina Faso and Malawi.

Figure 3 is an illustration of the various functions and channels in a tree seed market with an institutional environment composed of different actors and mechanisms influencing their interaction. The figure also points to where interventions could improve quality and choice in each channel, and indicates where the participation of actors could be broadened. The most important aspects, functions and channels will be described in the following.

3.2 Functions: the links in the input supply chain and different seed supply models

The functions correspond to the three links in the input supply chain (see figures 2 and 3).

The major functions are:

(i) Sources, which constitute the available genetic resources of species. The quality of sources depends on conservation, domestication, selection, breeding and final deployment.

(ii) Seed procurement, which is determined by who owns and/or controls the seed sources, and by their capacity and willingness to use them. How germplasm is procured has a major effect on who benefits from the germplasm. If procurement involves several links that overlap with distribution, it is convenient to locate wholesale below procurement.

(iii) Distribution, which should include documentation and certification of genetic quality, and documentation of germination quality. Distribution involves a retail network of seed and seedlings. The efficiency and reach of distribution is linked to efficiency of extension and marketing of species, varieties and provenances.

The input supply chain (see figure 2) can be organised as centralised or decentralised. Each of the three links or functions can be organised in a

<table>
<thead>
<tr>
<th>Seed Supply Model</th>
<th>Example of operational Seed Supply Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Centralised models</strong></td>
<td></td>
</tr>
<tr>
<td>CCC</td>
<td>Centralised government/large NGO model, e.g. many national tree seed programmes</td>
</tr>
<tr>
<td>CDC</td>
<td>Contract worker or day labourer model, where only collection is outsourced</td>
</tr>
<tr>
<td>DCC</td>
<td>Centralised outgrower model, procurement done by distributor</td>
</tr>
<tr>
<td>DDC</td>
<td>Centralised outgrower model, procurement done by producer</td>
</tr>
<tr>
<td><strong>Decentralised models</strong></td>
<td></td>
</tr>
<tr>
<td>DDD</td>
<td>Decentralised seed sources, decentralised enterprise model</td>
</tr>
<tr>
<td>DDD</td>
<td>Farmer to farmer diffusion model</td>
</tr>
<tr>
<td>CDD</td>
<td>Centralised seed sources, decentralised enterprise model</td>
</tr>
</tbody>
</table>
centralised (C) way (one or a few organisations control the link) or in a de-
centralised (D) way (many organisations control the link). Of the possible
combinations of the links in the value chain, the combinations most fre-
quently found in practise are shown in table 2.

The completely centralised model (CCC) is used by the national tree centres
and some large NGOs. The CDD and the DDD models are those of small-
scale enterprises. The other DDD model is the non-commercial diffusion
from farmer to farmer (exchange between neighbours, family and friends).
CDC is sometimes used by government agencies as a cost-reducing measure
(by asking local people to collect seed as hired labourers, instead of using
government staff). The DDC and DCC are outgrower models often used by
NGOs for distribution of seed from farmland sources.

The pros and cons of the various combinations of centralised and decen-
tralised organisation depend, among other factors, on the types of seed
sources. As described above, maintenance and protection of seed sources
is a major constraint in the case of centralised seed supply models, as these
tasks require substantial economic and human resources. However, in the
case of decentralised sources, owners must be assured that their invest-
ments in sources will pay off through sales of reproductive material, and
that requires access to and creation of markets, a condition that is rarely
fulfilled. The nature and species of some seed source types determine the
most appropriate model, but there is always some scope for modifying the
organisation of procurement and distribution.

Table 3. The 5 general types of sources

<table>
<thead>
<tr>
<th>Source type</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Forest</td>
<td>Natural vegetation, ranging from high forest to woodlands</td>
</tr>
<tr>
<td>Farmland</td>
<td>Tree species on farms - planted or remnants of natural vegetation</td>
</tr>
<tr>
<td>Plantations</td>
<td>Trees planted in a plantation or woodlot</td>
</tr>
<tr>
<td>Seed Orchards</td>
<td>Trees planted in a plantation or woodlot, specifically for seed production</td>
</tr>
<tr>
<td>Vegetative material</td>
<td>Grafts, stem cuttings, micro cuttings or somatic embryos propagated from</td>
</tr>
<tr>
<td></td>
<td>selected clones or seedlings. May originate from any of the other source types</td>
</tr>
</tbody>
</table>
3.3 Seed sources and market channels

There are five general types of sources of reproductive material, four of which are from seed and one from vegetative material, see Table 3. Domestication strategies for species depend on the availability and choices of seed sources. The type of sources determines, to a large extent, how procurement and distribution can be organised. The quality of the material produced is evaluated differently for each type of source. In most cases, it is therefore convenient to describe the flows of reproductive material as ‘source’ channels (see Figure 3).

Box 3. Seed sources and market channels

The natural forest sources contain a large range of useful tree and shrub species of high genetic quality, but are rarely if ever utilised. Instead a few of these species that are found in farmland are utilised as sources of dubious genetic quality. Most natural forest sources (they are often protected areas) are owned by government organisations and there are most often severe restrictions on NGOs and private to carry out collection of high quality seed. Very little seed from natural forest sources is distributed.

Plantation sources contain few species of which most are industrial plantation species, often the genetic origin is unknown and the sources are utilised indiscriminately in many different planting zones, including where they are not adapted. Most of the plantations are on government forest land and access for NGOs and private to collect depends on government regulations. NGOs regularly distribute seed of a few species.

Farmland contains remnants of natural vegetation as well as species deliberately introduced to farmers through projects and NGOs. Although there may be many species in the landscapes as a whole, there are typically a few dominant species. The genetic quality in general is unknown, but through the application of some common sense principles a reasonable genetic quality can be collected from many of the species in farmland. Typically such principles are not applied. A large number of actors collect seed from farmland sources in particular the smallholders themselves, small scale nurseries, small and large NGOs as well as government organisations. Quantitatively farmland sources is the most important of the five source types (except perhaps for fruit tree species) for planting material for smallholders. The importance can probably be explained purely by ease of access. NGOs are probably the largest distributors of farmland source seed and seedlings.

Seed orchards are typically rare and almost exclusively established on government land, in a few cases they have been established on other types of land by progressive NGOs. They contain a very limited number of species, but in many cases the genetic quality is reasonably good for seed production, but often they contain too little genetic variability to be utilised for further breeding. Collection and distribution is most often controlled by government or research organisations and their production capacity is very limited.

Vegetative propagation is typically carried out by government horticultural stations of a limited range of well known fruit tree species, occasionally NGOs or private produce grafted seedlings. Production and distribution from government horticultural stations is typically much lower than potential demand, and (unless on a commercial basis) NGO production is limited by project lifespan. The distribution of grafted seedlings is often of a limited range. In some cases indigenous (non fruit) species are vegetatively propagated from unknown material due to a perceived shortage of seed - most often this is the result of sub optimal planning rather than a real shortage.
The source types also tend to determine which actors most typically control the sources. Some characteristics of the sources and their respective market channels are described in box 3.

Overall, the ‘source’ channels are not optimally utilised, and genetic quality is usually disregarded. Most of the investment by government organisations, donor projects and NGOs goes into procurement and distribution of seed and seedlings, and the alternative of supporting incipient producer and distributor networks is not considered.

### 3.4 The institutional environment, the different actors and their roles

The *institutional environment* consists of the formal and informal rules that affect the sub-sector, as well as the organizations that support them. Rules include business laws (e.g. rules and conditions for small scale entrepreneurs, rules and practises for obtaining credit for smallholders’ and small scale entrepreneurs’ commercial activities), seed policy (rules and regulations concerning reproductive material), forest and agricultural policies, policies with respect to development of smallholder products markets and other economic issues, as well as socio-cultural factors, such as traditions for smallholder tree planting.

The purpose of analysis of the institutional environment will be to identify constraints and opportunities. Are policies enabling or constraining for development of an efficient production, procurement and distribution of input material?

Typically the national seed policy will only be for crop seed, but some of these rules may be applied to the tree seed sector. For example it is common that all seed lots should formally be tested for germination capacity at the National Tree Seed Centre and de facto this is largely disregarded. Few of the actors in the tree seed sector are aware of the possibilities for improving the capacity of decentralised tree seed systems through more efficient control and support systems, such as Quality Declared Seed (QDS), Truth in Labelling (TiL), use of portable moisture meters for testing in the field, etc. The knowledge of concepts of genetic quality will typically only exist at the NTSCs.

Typical support organisations (or actors) in the input supply chain are (in the formal support system) national tree seed centres, international and national NRM research centres; (in the informal support system) NGOs and projects. These support organizations most often organize their own production and supply chains regardless of the existence of a private sector that could handle the chains and that could improve efficiency and quality with help from the support organizations.

In several countries small-scale entrepreneurs (private nurseries and seed dealers) have started appearing, but there are many barriers to their efficient
participation in input supply markets. Access to credit for small scale entrepre- neurists may be difficult due to lack of facilities to smallholders and is further aggravated by the lack of recognition by the formal sector (in many countries seed distribution is formally a monopoly of the NTSCs). The role of extension systems often include public provision of free germplasm and almost never include support to private entrepreneurs.

Planting of trees is still in many countries seen as a forestry activity even though the large majority of planters is smallholder farmers planting trees on agricultural land. This often results in a bureaucratic disconnect and confusion between line ministries.

The purpose of analysis of actors is thus to identify constraints and opportunities and to prepare for a dialogue with and between sub-sector participants, and support organisations on how the dynamics and competitiveness of the sub-sector can be improved.

Table 4. Actors’ roles in the input supply chains

<table>
<thead>
<tr>
<th>Type of actor</th>
<th>Sources</th>
<th>Collection</th>
<th>Distribution</th>
<th>Institutional Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Tree Seed Centre</td>
<td>Limited capacity to maintain and protect</td>
<td>Expensive if done by staff. Important for mobilisation of species from natural forest</td>
<td>Limited reach</td>
<td>Commonly chosen role: Private business. Alternative role: supporter of market for small scale business</td>
</tr>
<tr>
<td></td>
<td>Can introduce foundation seed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>International &amp; National Research Centres</td>
<td>Limited capacity to maintain and protect</td>
<td>Expensive if done by staff. Can help introduce good material</td>
<td>Limited reach</td>
<td>Commonly chosen role: Deliver free seed that undermines market development. Alternative role: supporter of market for small scale business</td>
</tr>
<tr>
<td></td>
<td>Can introduce foundation seed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NGOs and projects</td>
<td>Limited time frame to maintain and protect</td>
<td>Expensive if done by staff. Can help introduce good material. Can support distribution networks</td>
<td>Limited reach</td>
<td>Commonly chosen role: Deliver free seed that undermines market development. Alternative role: supporter of market for small scale business</td>
</tr>
<tr>
<td></td>
<td>Can introduce foundation seed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large scale business</td>
<td>Very few species. Large scale business demands large returns on investments</td>
<td>Limited to out-grower business, controlled by large scale business</td>
<td>Limited to out-grower business, controlled by large scale business</td>
<td>Limited to out-grower business, controlled by large scale business</td>
</tr>
<tr>
<td>(e.g. paper industries, tobacco companies)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small scale business</td>
<td>Capacity unlimited and low demand on returns on investments. But require support for foundation seed and development of input and output markets</td>
<td>Cheap and efficient if part of markets. Potentially wide reach</td>
<td>Cheap, efficient if part of markets. Potentially wide reach</td>
<td>Common situation: Small scale business not recognised by the official support system. Alternative situation: Small scale business supported as a vehicle for improvement of smallholder production</td>
</tr>
<tr>
<td>(e.g. nurseries, seed dealers)</td>
<td></td>
<td></td>
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3.5 Leveraged interventions

Planting will typically vary by region, along with markets and end-uses of tree products and species. The regional variation springs from differences in geography, ecology, and population density. For this reason, targeted interventions reaching many participants may be difficult to replicate in other regions. In addition, policies to develop markets for smallholder products will influence which products are attractive to farmers, and may strongly influence demand for species and farmers’ planting choices.

In many other sectors, overcoming policy constraints constitutes a powerful point of leverage, but in the tree seed/seedling sector, policy reforms are more likely to be of secondary importance. Here, the main obstacle stems from the large-scale efforts of supporting agencies to provide free handouts, thus inhibiting the development of a private sector, which will not appear overnight.

The opportunities available for leveraged intervention in the tree seed/seedling sector will often call for a package of interventions, which will require collaboration between several actors with a common vision. Leveraged intervention will therefore require a dialogue between subsector participants, and support organizations, while being informed by the study of formal and informal rules, including possibilities for collective action (such as producer organisations and nursery associations).

The interventions should be targeted at developing an enabling environment for small-scale producers and distributors of tree seed and seedlings to create technical and business capacities among small entrepreneurs and to define new appropriate roles of actors (some of which were previously major distributors of free seed to farmers).

One of the most important criteria for efficient intervention is the presence of a division of labour between public and private actors, including the roles of NGOs (whose activities often substitute for government services). The roles of the different actors are summarised in table 4.

In the case of germplasm production-procurement-distribution chains, as a general principle, it is suggested that entities responsible for government services develop guidelines and training programmes (with support from NGOs) – including marketing and promotion of existing and new species, that NGOs conduct training programmes for small-scale entrepreneurs, support collective action by small-scale entrepreneurs (associations and networks); and that small-scale entrepreneurs produce, procure and distribute germplasm.
4. Conclusions

The patterns of tree planting in the tropics have changed over the past fifty years. The major change in tree planting has been the shift from industrial plantation establishment to tree planting by farmers on agricultural land, with a very large un-realised development potential.

In support of tree planting in the tropics, a global network of support institutions were established under the aegis of FAO in the 1970’s. A major part of this network was the establishment of national tree seed centres in some fifty countries as part of the development assistance by many industrialised countries. A large knowledge base was developed as a result of the implementation of the national seed programmes.

The role of these centres changed along with a shift in focus from industrial tree plantations towards support for tree planting by multitudes of smallholders, and it has been difficult for the centres (as well as for the donors) to adjust to the new situation, which requires different logistics to reach large numbers of smallholders with a wide range of species. Some of the national tree seed centres have therefore been privatised under the assumption that this would make them more efficient.

However, privatisation has not improved their efficiency in reaching smallholders, and most of the seed supply in the tropics has been taken over by NGOs distributing seed of suboptimal quality and of relatively few species. Consequently, the know-how built during years of national seed programme implementation is under-utilised. This poses an imminent danger of wasting the fruits of many years of investment by donors and governments.

The development of tree seed systems has followed a path very similar to that of crop seed systems. However, the new ideas and lessons learnt in crop seed systems have been slow to diffuse into the thinking on tree seed systems. Although there are biological differences between trees (perennials) and crops (annuals), the organisational and logistical aspects of seed production and supply are similar. The latest thinking on crop seed systems, albeit with some strategic adaptations, may serve to substantiate change in the currently dysfunctional tree seed systems, by creating efficient input supply chains capable of reaching smallholders with good quality material.

The overall objective of creating efficient input supply chains should be to improve the livelihoods and cash incomes of smallholders. In this process, a substantial degree of privatisation will be conducive to creating a demand-based supply. However, privatisation should be carried out with the overall objective in mind. As it has been realised for crop seed systems, private companies will not automatically start producing and selling seed to smallholders, because high transaction costs are involved in servicing poor smallholders.
Therefore, public support is still required in order to improve the economic environment for private sector participation, and the strategies for such support must be based on careful evaluation of the industry’s development potential. In many cases, the national tree seed centres hold an important part of the expertise to help evaluate the sector and to assist in the implementation of strategies.

To identify an appropriate model or models for seed supply in a given area, a sub-sector assessment is a useful tool for developing appropriate business development services. The objective of a sub-sector assessment is to analyse all of the participants, their linkages, and influential factors in the agribusiness system in order to identify constraints and opportunities for growth. The sub-sector review should explore opportunities for leveraged intervention, determining where opportunities for intervention and points of leverage converge. The following question should be answered: Which opportunities offer the best chance of reaching the largest number of participants within the sub-sector? If opportunities for leveraged intervention do exist, they constitute the skeleton for ‘action’ based on ‘good practise’.

Kiemtoro Moro, selfmade nursery man, in front of his nursery in Nobéré, Burkina Faso. He started the nursery inspired by a visit to Ghana, and produces 10-15,000 plants per year, which are sold mainly to local farmers and farmers’ associations. Phot. Anders Ræbild 2002.
Additional reading

This paper is based on several other documents, which are under preparation (working titles) and will provide more detailed information:

- Lessons learnt: tree seed supply (long background version)
- Trends in smallholder seed supply in the tropics
- Tree seed project fact sheets and survey of seed centres

Some key sources in relation to the two major aspects of good practise (appropriate technology and good governance) are:

**Appropriate technology**

Extensive practical experiences have been accumulated in the field of seed handling. Comprehensive documentation of topics, with abundant references, is provided by DFSC (now part of FLD), FAO, and World Agroforestry Centre (ICRAF):

**Schmidt, L. 2000:**


**Framework for good governance in seed programmes**

The issues of public/private support for seed centres and how to reach smallholders in order to improve their livelihoods through growing trees as crops have been discussed in many different contexts. Some of the most important sources are:

**Foster, G.S., Jones, N., Kjær, E.D. (1995)**
Graudal L. and Kjær E.D. 2001:

Miles, Theresa (Development Alternatives, Inc.). 1994.


Seed provision & agricultural development: the institutions of change.
Overseas Development Institute, London


NGOs and seed provision to smallholders in developing countries.
World Development 23: 413-422.